Toward a More Accurate Viscosity Scale for Dilute Gases

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Commercially-manufactured meters that measure the flow of a process gas are often calibrated with a known flow of a surrogate gas. This requires an accurate model of the flow meter and accurate values of the relevant thermophysical properties for both gases. In particular, calibrating a "laminar" flow meter near ambient temperature and pressure requires that the ratio (process gas viscosity)/(surrogate gas viscosity) be known within approximately 0.1 %. With this motivation, we reviewed measurements of viscosity near 25 °C and zero density for 11 gases: He, Ne, Ar, Kr, Xe, H_2, N_2, CH_4, C_2H_6, C_3H_8, and SF_6. For these gases and this single state, the viscosity ratios published by several groups (or calculated from pairs of their published viscosity values) have the desired small uncertainty. Anchoring the ratios to the value (19.82533 ± 0.00019) × 10^{-6} Pa s for the viscosity of helium calculated [1] *ab initio* at 25 °C and zero density establishes a scale for gas viscosities that is more accurate than most of the reported values. To facilitate the extension of this scale, we recommend that researchers who calibrate gas viscometers (1) use helium as a calibration gas when possible, (2) report the values of all calibration data, and (3) report the uncertainties of their measured viscosity ratios. Similarly, we recommend that data archives capture this relevant calibration information.

[1] Wojciech Cencek, Michal Przybytek, Jacek Komasa, James B. Mehl, Bogumil Jeziorski, and Krzysztof Szalewicz "Effects of adiabatic, relativistic, and quantum electrodynamics interactions on the pair potential and thermophysical properties of helium", J. Chem. Phys., to be submitted (2011)